CLAIMS

What is claimed is:

1. An apparatus comprising:

a first balancer to generate a first balancing signal from a first signal of a first index corresponding to a first frequency; and

a first combiner coupled to the first balancer to combine the first balancing signal and a second signal of a second index corresponding to a second frequency, the second frequency being symmetrical to the first frequency with respect to a center frequency in a multi-carrier signal, the first combiner generating a first balanced signal corresponding to the second frequency.

2. The apparatus of claim 1 wherein the first balancer comprises:

a first converter to convert the first signal into a first complex conjugate; and

a first multiplier coupled to the first converter to multiply the first complex conjugate with a first balancing parameter, the first balancing parameter corresponding to the first frequency, the first multiplier generating the first balancing signal.

3. The apparatus of claim 1 wherein the first combiner includes a first subtractor to subtract the first balancing signal from the second signal to provide the first balanced signal.

4. The apparatus of claim 1 wherein the first balanced signal is a first desired signal scaled by a first complex factor.

5. The apparatus of claim 1 wherein the first signal is provided by a first sub-carrier demodulator operating at the first frequency.

6. The apparatus of claim 4 wherein the first desired signal is a first demodulated signal.

7. The apparatus of claim 1 further comprising:

a second balancer to generate a second balancing signal from the second signal; and

a second combiner coupled to the second balancer to combine the second balancing signal with the first signal at a second frequency, the second combiner generating a second balanced signal at the first frequency.

8. The apparatus of claim 7 wherein the second balancer comprises:

a second converter to convert the second signal into a second complex conjugate; and

a second multiplier coupled to the second converter to multiply the second complex conjugate with a second balancing parameter, the second balancing parameter corresponding to the second frequency, the second multiplier generating the second balancing signal.

9. The apparatus of claim 7 wherein the second combiner includes a second subtractor to subtract the second balancing signal from the first signal to provide the second balanced signal.

10. The apparatus of claim 7 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

11. The apparatus of claim 7 wherein the second signal is provided by a second sub-carrier demodulator operating at the second frequency.

12. The apparatus of claim 10 wherein the second desired signal is a second demodulated signal.

13. The apparatus of claim 2 wherein the first balancing parameter is a ratio between output of the second sub-carrier demodulator and a conjugate output of the first sub-carrier demodulator when the multi-carrier signal contains a first sub-carrier signal modulated by a non-null complex number and a second sub-carrier signal modulated by a null complex number during a training process.

14. The apparatus of claim 8 wherein the second balancing parameter is a ratio between output of the first sub-carrier demodualtor and a conjugate output of the second sub-carrier demodulator when the multi-carrier signal contains a first sub-carrier signal modulated by a null complex number and a second sub-carrier signal modulated by a non-null complex number during a training process .

15. The apparatus of claim 1 wherein the first signal is a first original signal to be transmitted.

16. The apparatus of claim 1 wherein the first desired signal is provided to a first sub-carrier modulator operating at the first frequency.

17. The apparatus of claim 16 further comprising:

a second balancer to generate a second balancing signal from the second signal; and

a second subtractor coupled to the second balancer to subtract the second balancing signal from the first signal at a second frequency, the second subtractor generating a second balanced signal at the first frequency.

18. The apparatus of claim 17 wherein the second balancer comprises:

a second converter to convert the second signal into a second complex conjugate; and

a second multiplier coupled to the second converter to multiply the second complex conjugate with a second balancing parameter, the second balancing parameter corresponding to the second frequency, the second multiplier generating the second balancing signal.

19. The apparatus of claim 17 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

20. The apparatus of claim 19 wherein the second desired signal is provided to a second sub-carrier modulator operating at the second frequency.

21. The apparatus of claim 20 wherein one of the first and second balancing parameters is obtained during a training process.

22. The apparatus of claim 21 wherein the first balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second frequencies when the multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired signal, the first desired signal being a non-null complex number and the second desired signal being a null complex number during the training process.

23. The apparatus of claim 21 wherein the second balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second frequencies when the multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired signal, the first desired signal being a null complex number and the second desired signal being a non-null complex number during the training process.

24. A method comprising:

generating a first balancing signal from a first signal of a first index corresponding to a first frequency using a first balancer; and

combining the first balancing signal and a second signal of a second index corresponding to a second frequency using a first combiner, the second frequency being symmetrical to the first frequency with respect to a center frequency in a multi-carrier signal, the first combiner generating a first balanced signal corresponding to the second frequency.

25. The method of claim 24 wherein generating a first balancing signal comprises:

converting the first signal into a first complex conjugate by a first converter; and

multiplying the first complex conjugate with a first balancing parameter by a first multiplier, the first balancing parameter corresponding to the first frequency, the first multiplier generating the first balancing signal.

26. The method of claim 24 wherein the first combiner includes a first subtractor to subtract the first balancing signal from the second signal to provide the first balanced signal.

27. The method of claim 24 wherein the first balanced signal is a first desired signal scaled by a first complex factor.

28. The method of claim 27 wherein the first signal is provided by a first sub-carrier demodulator operating at the first frequency.

29. The method of claim 28 wherein the first desired signal is a first demodulated signal.

30. The method of claim 29 further comprising:

generating a second balancing signal from the second signal using a second balancer; and

combining the second balancing signal with the first signal at a second frequency using a second combiner, the second combiner generating a second balanced signal at the first frequency.

31. The method of claim 30 wherein generating the second balancing signal comprises:

converting the second signal into a second complex conjugate by a second converter; and

multiplying the second complex conjugate with a second balancing parameter by a second multiplier, the second balancing parameter corresponding to the second frequency, the second multiplier generating the second balancing signal.

32. The method of claim 30 wherein the second combiner includes a second subtractor to subtract the second balancing signal from the first signal to provide the second balanced signal.

33. The method of claim 30 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

34. The method of claim 33 wherein the second signal is provided by a second sub-carrier demodulator operating at the second frequency.

35. The method of claim 34 wherein the second desired signal is a second demodulated signal.

36. The method of claim 30 wherein the first balancing parameter is derived from outputs of the first and second sub-carrier demodulators when the multi-carrier signal contains the first sub-carrier signal modulated by a non-null complex number and the second sub-carrier signal modulated by a null complex number during a training process.

37. The method of claim 30 wherein the second balancing parameter is derived from outputs of the first and second sub-carrier demodulators when the multi-carrier signal contains the first sub-carrier signal modulated by a null complex number and the second sub-carrier signal modulated by a non-null complex number during a training process.

38. The method of claim 26 wherein the first signal is a first original signal to be transmitted.

39. The method of claim 38 wherein the first desired signal is provided to a first sub-carrier modulator operating at the first frequency.

40. The method of claim 39 further comprising:

generating a second balancing signal from the second signal by a second balancer; and

subtracting the second balancing signal from the first signal at a second frequency by a second subtractor, the second subtractor generating a second balanced signal at the first frequency.

41. The method of claim 40 wherein generating the second balancing signal comprises:

converting the second signal into a second complex conjugate by a second converter; and

multiplying the second complex conjugate with a second balancing parameter by a second multiplier, the second balancing parameter corresponding to the second frequency, the second multiplier generating the second balancing signal.

42. The method of claim 40 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

43. The method of claim 42 wherein the second desired signal is provided to a second sub-carrier modulator operating at the second frequency.

44. The method of claim 43 wherein one of the first and second balancing parameters is obtained during a training process.

45. The method of claim 44 wherein the first balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second frequencies when the multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired modulating signal, the first desired signal being a non-null complex number and the second desired signal being a null complex number during the training process.

46. The method of claim 44 wherein the second balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second

frequencies when the multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired modulating signal, the first desired signal being a null complex number and the second desired signal being a non-null complex number during the training process.

47. A system comprising:

in-phase (I) and quadrature (Q) processing chains to generate I and Q samples from a multi-carrier signal having P sub-carrier signals at P carrier frequencies;

a bank of demodulators coupled to the I and Q processing chains to demodulate the P sub-carrier signals, the bank of demodulators generating P demodulated signals; and

a balancing unit coupled to the bank of demodulators to restore P original signals from the P demodulated signals, the balancing unit including P basic blocks, each of the basic blocks comprising:

a first balancer to generate a first balancing signal from a first signal at a first frequency, and

a first subtractor coupled to the first balancer to subtract the first balancing signal from a second signal at a second frequency, the second frequency being symmetrical to the first frequency with respect to a center frequency in the multi-carrier signal, the first subtractor generating a first balanced signal at the second frequency.

48. The system of claim 47 wherein the first balancer comprises:

a first converter to convert the first signal into a first complex conjugate; and

a first multiplier coupled to the first converter to multiply the first complex conjugate with a first balancing parameter, the first balancing parameter corresponding to the first frequency, the first multiplier generating the first balancing signal.

49. The system of claim 47 wherein the first combiner includes a first subtractor to subtract the first balancing signal from the second signal to provide the first balanced signal.

50. The system of claim 47 wherein the first balanced signal is a first desired signal scaled by a first complex factor.

51. The system of claim 50 wherein the first signal is provided by a first sub-carrier demodulator operating at the first frequency.

52. The system of claim 51wherein the first desired signal is a first demodulated signal.

53. The system of claim 52 wherein each of the basic blocks further comprising:

a second balancer to generate a second balancing signal from the second signal; and

a second combiner coupled to the second balancer to combine the second balancing signal with the first signal at a second frequency, the second combiner generating a second balanced signal at the first frequency.

54. The system of claim 53 wherein the second balancer comprises:

a second converter to convert the second signal into a second complex conjugate; and

a second multiplier coupled to the second converter to multiply the second complex conjugate with a second balancing parameter, the second balancing parameter corresponding to the second frequency, the second multiplier generating the second balancing signal.

55. The system of claim 53 wherein the second combiner includes a second subtractor to subtract the second balancing signal from the first signal to provide the second balanced signal.

56. The system of claim 53 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

57. The system of claim 56 wherein the second signal is provided by a second sub-carrier demodulator operating at the second frequency.

58. The system of claim 57 wherein the second desired signal is a second demodulated signal.

59. The system of claim 53 wherein the first balancing parameter is derived from outputs of the first and second sub-carrier demodulators when the multi-carrier signal contains the first sub-carrier signal modulated by a non-null complex number and the second sub-carrier signal modulated by a null complex number during a training process.

60. The system of claim 53 wherein the second balancing parameter is derived from outputs of the first and second sub-carrier demodulators when the training multi-carrier signal contains the first sub-carrier signal modulated by a null complex number and the second sub-carrier signal modulated by a non-null complex number during a training process.

61. The system of claim 49 wherein the first signal is a first original signal to be transmitted.

62. The system of claim 61 wherein the first desired signal is provided to a first sub-carrier modulator operating at the first frequency.

63. The system of claim 62 further comprising:

a second balancer to generate a second balancing signal from the second signal; and

a second subtractor coupled to the second balancer to subtract the second balancing signal from the first signal at a second frequency, the second subtractor generating a second balanced signal at the first frequency.

64. The system of claim 63 wherein the second balancer comprises:

a second converter to convert the second signal into a second complex conjugate; and

a second multiplier coupled to the second converter to multiply the second complex conjugate with a second balancing parameter, the second balancing parameter

corresponding to the second frequency, the second multiplier generating the second balancing signal.

65 The system of claim 63 wherein the second balanced signal is a second desired signal scaled by a second complex factor.

66. The system of claim 65 wherein the second desired signal is provided to a second sub-carrier modulator operating at the second frequency.

67. The system of claim 66 wherein one of the first and second balancing parameters is obtained during a training process.

68. The system of claim 67 wherein the first balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second frequencies when the multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired modulating signal, the first desired signal being a non-null complex number and the second desired signal being a null complex number during the training process.

69. The system of claim 67 wherein the second balancing parameter is derived from outputs of first and second sub-carrier demodulators operating at first and second frequencies when the training multi-carrier signal is generated from the first and second sub-carrier modulators receiving the first and second desired modulating signal, the first desired signal being a null complex number and the second desired signal being a non-null complex number during the training process.

70. The apparatus of claim 1 wherein at least one of the first and second indices corresponds to a zero index.

71. The apparatus of claim 70 wherein at least one of the first and second signals corresponds to one of the center frequency and a DC of a baseband signal of the multi-receiver signal.